Hottest Life-Form Found: Microbe Thrives When Boiling

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for National Geographic News
May 21, 2004

Some can take the heat better than others. Scientists have discovered a deep-sea microbe that continues to grow and reproduce inside a high-pressure oven heated to 121 degrees Celsius (250 degrees Fahrenheit). Now they're wondering just how much heat the hardiest life-forms can take.

The microbe, known unofficially as Strain 121, is found where most such heat-loving microbes are found—several miles beneath the ocean surface, snuggled up in the walls of hydrothermal vents that spew mineral-enriched, scalding water.

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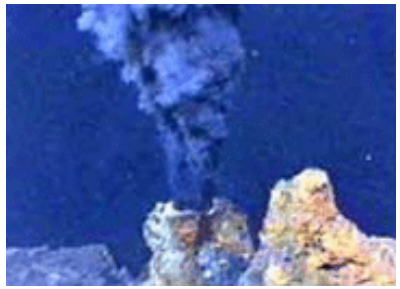

This "black smoker" vent is about 250 miles (400 kilometers) south of Finn, the vent that yielded the Strain 121 microbe sample. The microbe is the first known organism to thrive at temperatures above 250 degrees Fahrenheit (121 degrees Celsius).

Image courtesy of Pacific Marine Environmental Laboratory, NOAA.

Funding for this Earth-systems science story was provided by the National Science Foundation. This special series of news stories is produced as a complement to *Pulse of the Planet*, a daily sound portrait of the Earth broadcast on radio.

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Last year Derek Lovley, a professor of microbiology at the University of Massachusetts, Amherst, and Kazem Kashefi, a postdoctoral researcher, isolated Strain 121 from a chunk of vent that had been hauled from the ocean floor.

When the researchers placed it inside a high-pressure cooker called an autoclave—normally used to sterilize medical equipment at 121 degrees Celsius (250 degrees Fahrenheit)—the strain continued to grow and reproduce.

"That temperature was known to kill all previous life," Lovley said. "So getting over that level is an increase of how high the temperature can be before life can't exist."

Though it stopped reproducing and growing at 121 degrees Celsius, Strain 121 remained stable at 130 degrees Celsius (266 degrees Fahrenheit).

Previously, the upper known temperature limit for life had been 113 degrees

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Celsius (235 degrees Fahrenheit), a record held by another heat-loving microbe called *Pyrolobus fumarii.*

Craig Cary, an expert on high-temperature microbes at the University of Delaware in Lewes, said the discovery of Strain 121 is an "incredible" feat. But he suspects microbes that exceed the 121 degrees Celsius barrier are still to be found.

"This is not a needle in the haystack, this is a needle in the whole haystack of Kansas—there's got to be others out there," he said.

Discovery

The sample of Strain 121 cultured by Lovley and Kashefi was collected from a hydrothermal vent about 200 miles (322 kilometers) off of Washington State and nearly 1.5 miles (2.4 kilometers) deep in the Pacific Ocean.

A crew of University of Washington scientists led by oceanographer John Delaney used a remotely operated submarine to retrieve the sample from the Juan de Fuca Ridge. the ridge is a lightless seascape where spewing vents called black smokers rise up like three- and four-story chimneys.

The sample was then sent to Lovley's lab at the University of Massachusetts, where, in an attempt to isolate microbes that grow on iron, they discovered Strain 121.

Lovley and his colleagues have yet to formally name Strain 121, a process that requires publication of the name in a peer-reviewed scientific journal. To have the paper accepted, two cultures of the strain must be publicly available.

"The problem is, culture collections are not able to deal with" the rigors of handling, he said. Strain 121 is a novel-type of organism: It uses iron to get energy from its food in the same manner that we humans use oxygen to get energy from our food.

Chemically, Strain 121's respiration process reduces ferric iron to ferrous iron and forms the mineral magnetite, the source of most of the magnetic material deposited on Earth some two billion years ago.

Though Lovley is a master of isolating and growing such iron-loving microbes, Cary said the task is very difficult to do and few people can match Lovley's expertise.

"Extremophiles are difficult to grow," Cary said. "They are living under very specific constraints, environmental and nutrient constraints, and getting it just right is very hard. ... [Lovley] had a system that was very constrained, and he was able to pull these bugs out."

Strain 121 is an archaean, a single-celled microbe similar to but not quite like bacteria. Archea often live in extreme environments, such as extreme heat, cold, salinity, or acidity.

"Archaea" literally means "ancient." The organisms are so named because they split from the tree of life close to the roots.

Taking the Heat

Lovley and his colleagues are currently attempting to sequence the genome of Strain 121 in order to understand how the microbe is able to survive

temperatures above the sterilization threshold of 121 degrees Celsius.

"In general, the factors that allow organisms to grow at high temperatures are not well understood," Lovley said.

Jan Amend, a microbial geochemist at Washington University in St. Louis, believes Strain 121 is just "one of many microbes" that can survive at such high temperature. He doesn't think the survival skill of Strain 121 "is anything super out of the ordinary."

"Like every living organism, it requires carbon, nutrients, energy, water, and a few other things that all of life requires," he said. Strain 121, he added, has happened to adapt to a hot environment and energy source of ferric iron.

Cary said that what is amazing about microbes such as Strain 121 is that their DNA holds together, replicates, and functions at temperatures that cause most other known organisms to wilt.

"It is mind-boggling. We are just now getting to a place to understand the intricacies of thermal adaptations," he said.

According to Cary, microbes such as Strain 121 likely have a suite of adaptations at the genetic level that allow them to survive. "These guys have been on the planet for 3.5 billion years. They've had a heck of a long time to figure it out," he said.

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